



(19)

Europäisches Patentamt
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(11)

EP 1 513 369 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.03.2005 Bulletin 2005/10

(51) Int Cl.7: H04R 7/00

(21) Application number: 04020857.1

(22) Date of filing: 02.09.2004

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR LT LV MK

(30) Priority: 02.09.2003 JP 2003310242

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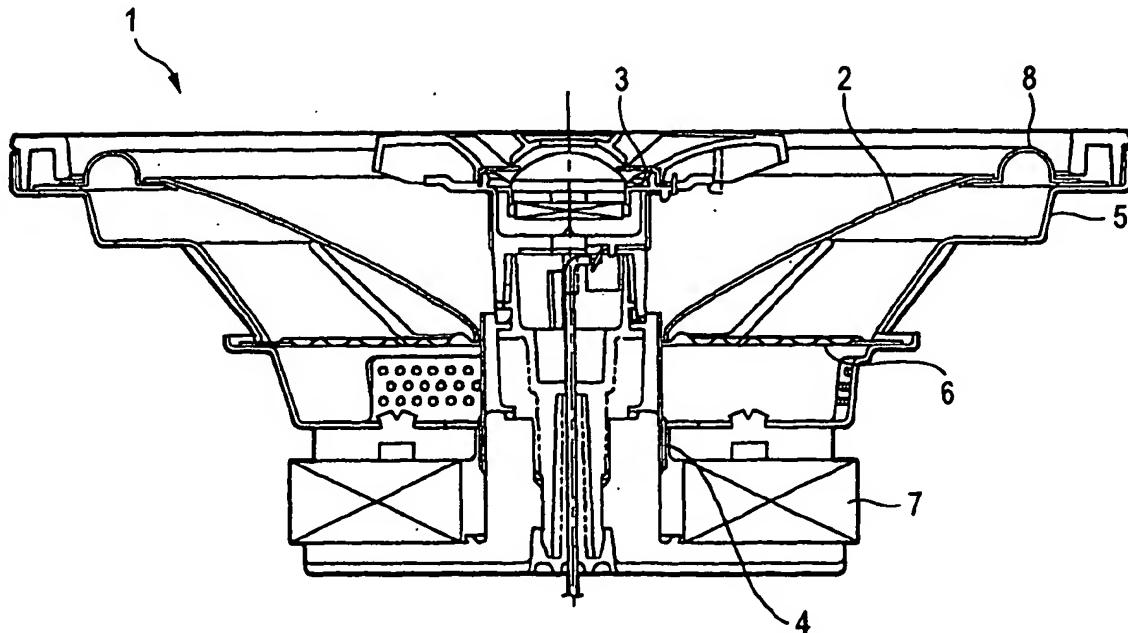
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(54) Speaker diaphragm and speaker using the diaphragm

(57) A speaker diaphragm outputting a voice with vibrations of a voice coil, includes a base substance and a polyethylene naphthalate fiber sheet laminated on the

base substance. The polyethylene naphthalate fiber sheet includes a polyethylene naphthalate fiber impregnated with a resin and is formed like a sheet.

FIG. 1



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Description**BACKGROUND OF THE INVENTION****1. Field of the invention**

[0001] The present invention relates to a speaker diaphragm used for various kinds of acoustic apparatuses or information communication apparatuses and a speaker having the diaphragm.

2. Description of the Related Art

[0002] A speaker is employed as sound outputting means in various kinds of acoustic apparatuses or information communication apparatuses. Generally, if a sound signal is passed through a voice coil, the voice coil vibrates a cone that is a diaphragm so that the sound is outputted.

[0003] The material of the cone may be a natural fiber, a chemical fiber, a synthetic material synthesized of them, and the synthetic material impregnated with a solution of acrylic resin or polyurethane resin.

[0004] A speaker having a cone in which a foam resin sheet, an elastomer or non-woven fabric is laminated on a base substance made of polyethylene naphthalate resin is well known (e.g., refer to JP-A-2001-204094).

[0005] By the way, the speaker is formed by laminating the foam resin sheet, elastomer or non-woven fabric having a high internal loss on the base substance made of polyethylene naphthalate resin to reduce resonance and realize high sound quality. In recent years, there is a demand for reproducing the sound of high quality extremely nearer to the natural sound, for which the speaker comprises the cone made of material with less resonance.

SUMMARY OF THE INVENTION

[0006] The present invention has been made in view of the above circumstances. It is an object of the Invention to provide a speaker diaphragm capable of reproducing the sound of high quality extremely nearer to the natural sound and a speaker having the diaphragm.

[0007] According to a first aspect of the invention, a speaker diaphragm outputting a voice with vibrations of a voice coil, includes a base substance and a polyethylene naphthalate fiber sheet laminated on the base substance. The polyethylene naphthalate fiber sheet includes a polyethylene naphthalate fiber impregnated with a resin and is formed like a sheet.

BRIEF DESCRIPTION OF THE DRAWINGS**[0008]**

Fig. 1 is a cross-sectional view of a speaker for explaining a speaker structure having a speaker dia-

phragm according to an embodiment of the invention; and

Fig. 2 is a cross-sectional view of a main cone for explaining a diaphragm structure provided on the speaker.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 **[0009]** A speaker diaphragm according to an embodiment of the present invention will be described below.

[0010] The diaphragm of this embodiment is employed for a speaker for outputting the sound by vibrations of a voice coil, and includes a base substance and a PEN (polyethylene naphthalate) fiber sheet laminated on the base substance. The PEN fiber sheet is formed like a sheet by impregnating the polyethylene naphthalate fiber with resin.

[0011] The speaker diaphragm according to this embodiment has a multiple structure in which the PEN fiber sheet is bonded on the base substance, whereby making it possible to increase the internal loss while keeping the good rigidity, and greatly reduce the unwanted resonance to reproduce the sound of high quality nearer to the natural sound.

20 **[0012]** Also, if the density or thickness of the polyethylene naphthalate fiber contained in the PEN fiber sheet, as well as the thickness of resin are changed, the output characteristics can be adjusted according to the requirements, whereby the diaphragm can be employed for a wide range of uses.

[0013] The speaker diaphragm of this embodiment may have the PEN fiber sheet bonded on the base substance by a resin film including thermoplastic resin. Such speaker diaphragm has a high rigidity and can produce a natural sound quality, because the base substance and the PEN fiber sheet are strongly integrated by the resin film including a thermoplastic resin.

30 **[0014]** Moreover, the speaker diaphragm of this embodiment may have the PEN fiber sheet bonded on the base substance by adhesives. Such speaker diaphragm has a high rigidity and can produce a natural sound quality, because the base substance and the PEN fiber sheet are strongly integrated by the adhesives.

[0015] The speaker having the speaker diaphragm of this embodiment has the diaphragm connected to the voice coil on the inner circumferential side, and produces the sound when the diaphragm is vibrated by this voice coil. And the diaphragm includes the base substance and the PEN fiber sheet laminated on the base substance. The PEN fiber sheet is formed like a sheet by impregnating the polyethylene naphthalate fiber with

40 **[0016]** The speaker having the speaker diaphragm of this embodiment has the diaphragm connected to the voice coil on the inner circumferential side, and produces the sound when the diaphragm is vibrated by this voice coil. And the diaphragm includes the base substance and the PEN fiber sheet laminated on the base substance. The PEN fiber sheet is formed like a sheet by impregnating the polyethylene naphthalate fiber with

resin.

[0016] The speaker of this embodiment can increase the internal loss while keeping the good rigidity, greatly reducing the unwanted resonance, and reproduce the sound of high quality nearer to natural sound, because the diaphragm has a multiple structure in which the PEN fiber sheet is bonded on the base substrate.

[Examples]

[0017] The diaphragm and the speaker having the diaphragm according to this embodiment will be described below by referring examples with reference to the accompanying drawings.

[0018] Fig. 1 is a cross-sectional view of the speaker according to this embodiment.

[0019] As shown in Fig. 1, this speaker 1 is a double cone type having a main cone 2 and a sub-cone 3 for high frequency reproduction provided inside a main cone 2. The main cone 2 and the sub-cone 3 are vibrated as the diaphragm to produce the sound. The speaker 1 of the double cone type improves the high frequency characteristics compared with the one cone speaker and can reproduce the sound in a wide band.

[0020] In this speaker 1, the voice coil 4 is held by a damper 6 attached to a frame 5.

[0021] The main cone 2 is a neck portion attached to the voice coil 4 on their inner circumferential side. And the main cone 2 is provided with an edge 8 connected to the frame 5 on their outer circumferential side.

[0022] The main cone 2 and the sub-cone 3 for the speaker 1 of the above structure will be detailed below taking the main cone 2 as an example.

[0023] Fig. 2 is a cross-sectional view of a part of the main cone 2.

[0024] As shown in Fig. 2, a cone substance 11 constituting the main cone 2 has a multi-layer structure having the base substrate like a sheet and the PEN (polyethylene naphthalate) fiber sheet 13 laminated on the surface of this base substance 12.

[0025] The base substance 12 supports the PEN fiber sheet 13, and includes a paper material, a resin material or a metal material. Preferably, a paper material is blended with an aramid fiber, in the thickness being about 0.20mm. As an aramid fiber blended into paper material, Kevlar including para aromatic polyamide or Cornex including meta aromatic polyamide is usable.

[0026] The PEN fiber sheet 13 is formed like a sheet by impregnating PEN fiber with a resin.

[0027] PEN fiber included in this PEN fiber sheet 13 is made in thickness of about 0.25mm by weaving resin yarn having a size of about 1000 denier. The pen fiber is processed into a sheet-state by impregnating PEN fiber with resin of about 15 to 20% in weight based on the total weight of the PEN fiber to produce the PEN fiber sheet 13.

[0028] As the resin impregnated to the PEN fiber, a thermoplastic or thermosetting resin may be employed.

Examples of such resin may include thermosetting resins such as phenol resin, epoxy resin, melamine resin, vinyl ester resin, urethane resin, unsaturated polyester resin, and ultraviolet curable resin, and thermoplastic resins such as polypropylene, polyethylene, nylon, polyethylene terephthalate, polybutylene terephthalate, polycarbonate, polyimide and polyether imide.

[0029] And the PEN fiber sheet 13 is bonded on the surface of the base substance 12 using a thermoplastic 10 rein film or by adhesives to produce the cone substance 11.

[0030] To bond the PEN fiber sheet 13 on the base substance 12 using the thermoplastic resin film, the film is carried between the base substance 12 and the PEN

15 fiber sheet 13 and subjected the molding pressure of about 3kg/cm² at for about 10 seconds at temperatures from 170 to 200°C In this way, the base substance 12 and the PEN fiber sheet 13 are pressed together via the thermoplastic resin film softened by heat and integrated.

20 [0031] And a predetermined pressure is applied to the cone substance 11 having the PEN fiber sheet 13 bonded with the base substance 12 by the mold to produce a predetermined shape of main cone 2.

[0032] The sub-cone 3 is molded from the cone substance 11 with the PEN fiber sheet 13 bonded on the base substance 12, like the main-cone 2.

[0033] And with the cone substance 11 for the speaker and the speaker 1 having the cone substance 11, the internal loss is increased while the good rigidity is kept.

30 internal loss is increased while the good rigidity is kept, and the unwanted resonance is greatly reduced to reproduce the sound of high quality nearer to the natural sound, because the cone substance 11 has the multiple structure in which the PEN fiber sheet 13 is bonded on the base substance 12.

35 [0034] Further, the output characteristics can be adjusted according to a great demand or requirements of the customer by changing the density and thickness of a polyethylene naphthalate fiber contained in the PEN fiber sheet 13 and the size of resin yarn, whereby the

40 PEN fiber sheet 13 is usable in a wide range of uses.
[0035] Since the base substance 12 is preferably In-
cludes a paper material blended with an aramid fiber,
the elastic modulus and internal loss of the base sub-
stance are improved. Thereby, the sound quality is fur-
45 ther enhanced.

[0036] The base substance 12 is not limited to the paper material, but may be a resin sheet containing polyethylene naphthalate, polycarbonate or polyimide resin, or a metal sheet of titanium or aluminum, for example.

50 [0037] Though in the above example, the PEN fiber sheet 13 is bonded on the base substance 12 by the film containing thermoplastic resin, the PEN fiber sheet 13 may be bonded on the base substance 12 simply by adhesives.

Claims

1. A speaker diaphragm outputting a voice with vibrations of a voice coil, comprising:

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a base substance; and
a polyethylene naphthalate fiber sheet laminated on the base substance,

wherein the polyethylene naphthalate fiber sheet includes a polyethylene naphthalate fiber impregnated with a resin and is formed like a sheet.

2. The speaker diaphragm according to claim 1, further comprising a resin film including a thermoplastic resin, by which the polyethylene naphthalate fiber sheet is bonded onto the base substance

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3. The speaker diaphragm according to claim 1, the polyethylene naphthalate fiber sheet is bonded on the base substance by an adhesive.

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4. A speaker diaphragm according to claims 1, wherein the base substance comprises a paper material blended with an aramid fiber.

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5. A speaker comprising:

a voice coil; and
a diaphragm which is connected to the voice coil on an inner circumferential of the diaphragm and is vibrated by the voice coil to output sound, wherein the diaphragm comprises:

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a base substance; and
a polyethylene naphthalate fiber sheet laminated on the base substance,

wherein the polyethylene naphthalate fiber sheet includes a polyethylene naphthalate fiber impregnated with a resin and is formed like a sheet.

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FIG. 1

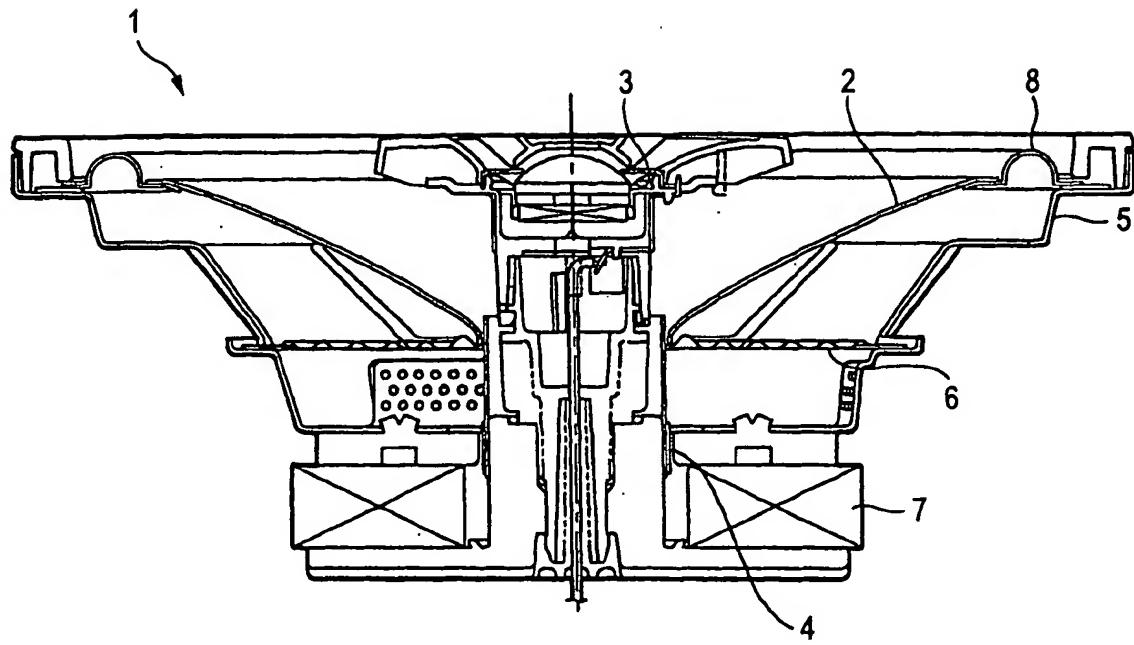


FIG. 2

